Sensitivity of Tropical Pacific Ocean General Circulation Model Simulations of Current and Temperature to ERS-1 Satellite Scatterometer Winds

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One of the initial objectives of the Tropical Oceans Global Atmosphere (TOGA) Program was to increase the accuracy of the surface wind field. No wind measurements were recorded in large oceanic areas every month and the physics of the atmospheric planetary boundary layer were not adequately parameterized in the atmospheric general circulation model (GCM). Aliasing errors would be diminished in wind data produced from satellite-borne instrumentation, which yields unprecedented spatial and temporal coverage of the surface wind over the global ocean.

The impact of satellite-derived surface wind components, which were recorded from the first European Remote Sensing (ERS-1) single-swath scatterometer, on tropical Pacific Ocean GCM simulations of current and temperature is determined. The primary question addressed in the paper is, are ocean GCM simulations created with ERS-1 and other types of wind products the same? Intercomparisons of current and temperature simulations created with four wind data products are discussed. Simulations were made with and without assimilation of surface and subsurface in situ temperature measurements. No single wind data source is likely to be free of errors, and the influence of assimilation of sparsely sampled in situ temperature data on a hindcast-analysis system of ocean thermal and flow fields will be discussed. Wind products were ERS-1, NMC, FSU, and a blended NMC and moored-buoy data set called NMC+TAO. The NMC+TAO wind data product contained all TAO observations, of which only a small portion was assimilated in the NMC forecast-analysis system. The FSU data product combined in situ ship and moored-buoy wind reports. The representativeness of results will be described with in situ observations, such as the moored current and temperature data that were recorded at about four sites along the equator that were not used in the data assimilation scheme.

The paper will focus on monthly mean surface and subsurface temperatures at the equator and monthly mean surface and subsurface currents, and integrated values, of the Equatorial Undercurrent (EUC) and North Equatorial Countercurrent (NECC) between 140°E and 80°W during April 1992 to March 1994. Whereas variations of temperature along the equator and EUC are primarily dependent upon zonal wind stress, the NECC variations are dependent upon wind-stress curl.

Without assimilation of temperature data, ERS-1 simulated SST along the equator in the eastern Pacific was too high and the depth of the 20°C isotherm along the equator was too deep compared with the NMC, NMC+TAO, and FSU simulations. Assimilation of temperature data reduced the difference between the ERS-1 simulated SST and depth of 20°C isotherm along the equator and those simulated with the other three winds. Influence of data assimilation in the temperature simulation was greatest for the ERS-1 computations,

The 140°E-80°W average 2-year mean and variance values of the EUC and NECC transports were considerably greater when temperature data were assimilated than when no data were assimilated, Without data assimilation, the ERS-1 simulated longitudinal average 2-year mean EUC transport and the associated variance were smaller than those simulated with NMC, NMC+TAO, and FSU winds; the opposite condition occurred with assimilation. With data assimilation, the 2-year mean ERS-1 simulated EUC core speed at 0°, 140°W was 15 cm s-1 less than those computed with the other winds; at 0°, 110°W the ERS-1 core speed was 20 cm s^{-1} greater than the other values; differences between NMC, NMC+TAO, and FSU simulated core speeds at the two sites were smaller than 5 cm s-1.